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**HABITAT AND AQUATIC MACROINVERTEBRATE  
SURVEY**

**EAST SPRING AND TRUMBULL CREEKS  
FLATHEAD COUNTY, MONTANA**

STATE DOCUMENTS COLLECTION

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## INTRODUCTION

In an attempt to reduce non-point source water pollution in the East Spring and Trumbull Creek watersheds, land management practices have been altered as part of a demonstration project, one of several in Montana. The success of these projects is partly gauged by changes in the benthic macroinvertebrate communities of the area's streams, since the analysis of these communities can be related to a stream's biological health or integrity. Biological integrity has been defined by Karr and Dudley (1981) as "the capability of supporting and maintaining a balanced, integrated, adaptive community of organisms having a species composition, diversity and functional organization comparable to that of natural habitat of the region." The framework for macroinvertebrate community analysis employed in these projects is an adaptation of the U.S. EPA's Rapid Bioassessment Protocols (RBP) (Plafkin et al. 1989).

## METHODS

Benthic macroinvertebrates were sampled from East Spring and Trumbull Creeks by personnel of the Montana Department of Environmental Quality (DEQ) on September 5, 1996. The traveling kick-net method described by Bukantis (1997) was utilized. Two samples were collected from each of two riffled reaches; from two other reaches single samples were obtained. The resulting six samples were numbered at sites described as follows:

- 1.1 and 1.2 from East Spring Creek at the Highway 35 crossing
- 2.0 from East Spring Creek at Granite View Drive
- 3.1 and 3.2 from Trumbull Creek at its mouth
- 4.0 from East Spring Creek below Farrier's dam.

Habitat parameters were scored using a DEQ-modified version of the U.S. EPA Rapid Bioassessment Protocols (RBP) (Plafkin et al. 1989).

### **Macroinvertebrate Sample Processing and Identification**

Laboratory and data analyses were contracted to BlueStem Incorporated. Macroinvertebrate samples were processed, sorted and enumerated by BlueStem Incorporated personnel, using the U.S. Environmental Protection Agency's techniques for RBP III (Plafkin et al. 1989). Taxonomic identification of the benthic macroinvertebrates was subcontracted by BlueStem Incorporated to Michael J. McBride.

Sample processing consisted of obtaining approximately a 300-organism subsample and was consistent with RBP III (Plafkin et al. 1989). Organisms were enumerated and identified whenever possible to the taxonomic level specified in the Montana DEQ SOP (Bukantis, 1996). The SOP requirements for subsampling and taxonomic resolution were strictly adhered to, deviating only when the quality of the specimen was lacking due to missing body parts needed for identification. When organisms were too immature to confidently take to the taxonomic level outlined in the SOP, they were more conservatively identified.

Following is a description of the subsampling procedure: Each sample was rinsed in a 0.5 mm sieve to remove preservative. The washed sample was then transferred to an appropriate size invertebrate sorting tray marked into square quadrants. Water was added to the tray to allow

complete dispersion of the sample and even distribution of the organisms. Quadrants were randomly selected and organisms removed from each quadrant until the total number of organisms fell within the range of 270 to 330 ( $\pm 10\%$  of 300 organisms), or until there were no more invertebrates to remove, whichever occurred first. Any organism lying over a line separated by two quadrants was considered to be in the quadrant containing its head.

Community structure, function and sensitivity to impact were characterized for each subsample using the same batteries of metrics used by McGuire (1995) in his earlier report on data from East Spring and Trumbull Creeks. Metrics generally include those recommended by DEQ for Montana Valley and Foothill Prairie streams. An internal reference approach is the major focus of the current analysis: a reference value for each metric was established for all sites based on the performance of that metric at all sites in all years studied. The best value in any year's data, if appropriate for the analysis, was chosen as the point of comparison, or reference value, for each metric used. Additionally, a comparison of 1996 data with the Montana Valleys and Foothill Prairies regional reference (Bukantis 1997) is briefly reported.

When replicated data were available, actual metric values for each replicate were averaged and the mean value was compared to the reference values to obtain metric scores. Total metric scores were obtained by summing scores for all metrics, and an impairment classification and a use support category for each site was derived from this total score. For purposes of comparison, the data from studies of 1989, 1990, 1991, 1992 and 1994 were recalculated using the updated internal reference values, resulting in some changes to impairment classifications assigned in those years.

Habitat assessment methods have been updated by DEQ since the earlier studies of East Spring and Trumbull Creeks, so scores from these studies were recalculated, and parameters and scoring were standardized to allow comparison among years. Recalculation resulted in changes in some of the condition categories assigned to sites in earlier years; the changes are reported herein. Table 5 illustrates methods used to arrive at comparable habitat assessments for this study.

## RESULTS AND DISCUSSION

### Habitat Assessment

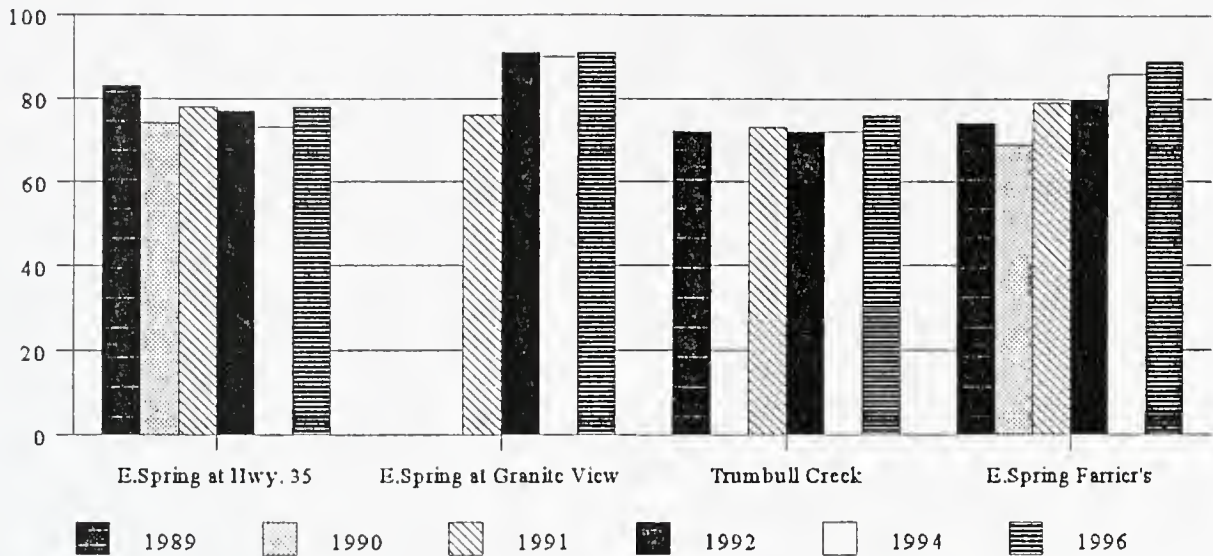
Figure 1 compares the results of habitat assessments from all study years, incorporating all parameters in use in all six years of study. Additional habitat assessment using only those parameters common to all six years' data, may be found in Table 5.

The habitat of East Spring Creek at Highway 35 was rated sub-optimal in 1996, with scores remaining consistently sub-optimal since 1990. Abbreviated riparian width continues to be the greatest influence on the total habitat score at this site. In addition, substrate embeddedness, channel alteration and sediment deposition were perceived to negatively influence the habitat quality here.

The site on East Spring Creek at Granite View Drive was judged optimal in each year since it was first evaluated in 1991. Sub-optimal riffle development, suggesting alterations in upstream or local geomorphology, was the only parameter scored lower than optimal in the 1996 evaluation.

Trumbull Creek near its mouth was rated sub-optimal in every year prior to 1996, when its

**Figure 1. Total habitat scores. East Spring and Trumbull Creeks. 1989-1996.**



perceived condition improved to optimal. Small improvements in embeddedness of substrate and flow status contributed to the higher score. Riparian width continued to be rated as poor.

Below Farrier's dam, the condition of East Spring Creek continues a trend of improvement which dates from 1990. Since the last assessment in 1994, riparian width was perceived to have increased considerably. Riffle development was considered poor in 1996, possibly as a result of geomorphologic alterations resulting from the upstream dam. Benthic substrate was rated sub-optimal.

### **Macroinvertebrate communities**

Macroinvertebrate taxa lists, metric results and other information for each replicate are given in Appendix A.

The percent similarity between 1996 replicates was 74% for those taken from East Spring Creek at Highway 35 and 61% for those taken near the mouth of Trumbull Creek. Percent similarity between sites was calculated based on combined replicates, and is displayed in Figure 2.

**Figure 2. Percent similarity between sites. East Spring and Trumbull Creeks: September 5, 1996.**

	at Highway 35	at Granite View	Trumbull at mouth
at Granite View	52.4		
Trumbull at mouth	51.4	55.1	
below Farrier's dam	29.1	20.1	22.7

Communities of East Spring Creek at Highway 35 and Granite view are quite similar to each other and with the community of the Trumbull Creek site, but the assemblage below Farrier's dam is distinctive.

Figure 3. Bioassessment scores. East Spring and Trumbull Creeks. 1989-1996.

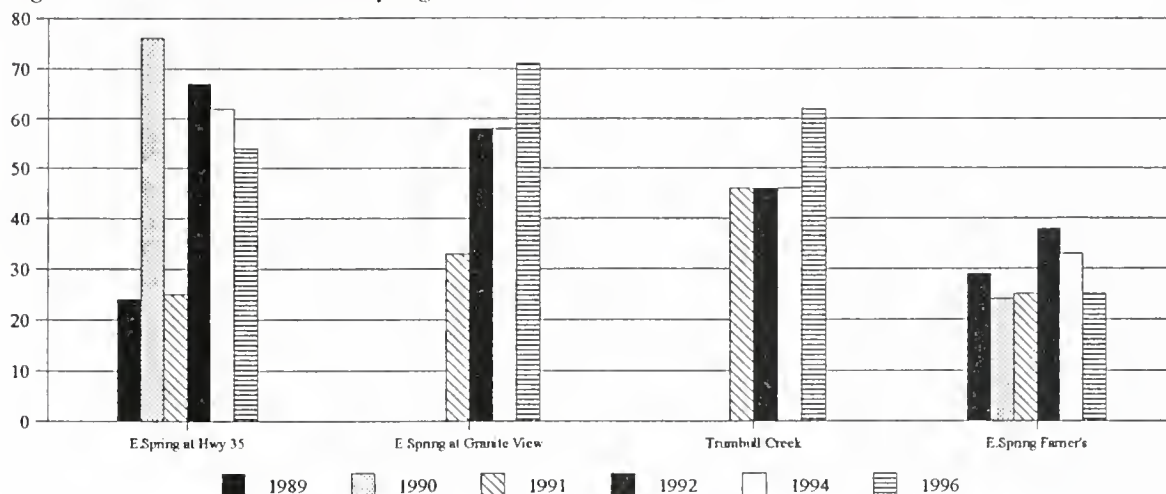


Figure 3 compares available total bioassessment scores for each site across all years studied. Bioassessment scores for 1989, 1990, 1991, 1992 and 1994 were recalculated based on updated reference values (Table 1). Recalculation resulted in some reclassifications since the report summarizing 1994 data (McGuire 1995) was submitted: the Trumbull Creek site was classified as slightly impaired in 1992 and 1994 based on the reference community devised in the 1995 report, but the site would have been considered moderately impaired based on the 1996 reference community. An error in the metric score calculations made in the 1995 report resulted in the classification of East Spring Creek at Highway 35 as moderately impaired in 1990: correction of the scores results in a non-impaired classification for that site in that year.

For East Spring Creek sites at Highway 35 and below Farrier's dam, comparison of data from 1989 and 1990 with that of more recent years is not entirely reliable, due to differences in sample size, taxonomic resolution and season of collection. Total bioassessment scores for these data were calculated using the metric Shannon's diversity ( $\log_2$ ) as a substitute for taxa richness and EPT richness, values for which are correlated with sample size. Replicate samples from East Spring Creek at Highway 35 collected in 1992 were combined to improve comparability with other data.

The lower (at Highway 35) and middle (at Granite View) reaches of East Spring Creek were classified as slightly impaired (54% of reference and 71% of reference respectively), based on the 1996 macroinvertebrate reference community metric scores. The upper reach (below Farrier's dam) showed moderate impairment (25% of reference). Trumbull Creek near its mouth was classified as slightly impaired (62% of reference). Compared to the Montana Valley and Foothill Prairie reference community metrics, all four sites showed moderate impairment in 1996.

At Highway 35, East Spring Creek total bioassessment scores have steadily declined since

1992. While taxa richness and the Shannon diversity measure have remained high, and EPT abundance has improved to some degree (from 12% in 1994 to 20% in 1996), the benthic community as a whole has shifted towards greater numbers of more tolerant taxa. Biotic index scores have risen nearly 30% in four years. The number of EPT taxa has fallen, mostly due to a loss of diversity among Trichoptera. The blackfly *Simulium* sp. and the tolerant midge *Eukiefferiella* spp. made up 40% of the benthic community at this site in 1996. In addition, scraping and (especially) shredding taxa have declined in numbers since 1994, being replaced by increasing numbers of filtering creatures. The composition of the community suggests organic and/or nutrient enrichment, and since habitat conditions appear to have remained stable, water quality seems to have worsened since 1994 at this site.

Judging only by the total bioassessment score, biotic health seems to have improved in the middle reach of East Spring Creek at Granite View, though evidence of organic and/or nutrient pollution remained. Annelids increased in abundance since 1994 (from 2% of the community in 1994 to 18% in 1996). In addition, chironomids, especially the tolerant genera *Eukiefferiella* and *Orthocladius* were more abundant in 1996. These shifts probably account for most of the upward change in biotic index score, indicating a more pollution-tolerant assemblage at this site. These negative indicators were offset in the tabulation of the total bioassessment score by an increase in diversity measured both by the Shannon diversity index and by taxa richness. Twenty-four taxa were reported in 1994, while 33 appeared in the sample taken in 1996. On closer inspection, however, it appears that the increase in total score may be misleading: of the nine additional taxa present in 1996, four are tolerant non-insects, and three are midges. An increase in taxa richness is often a positive sign in streams where habitat and water quality are improving. However, such an increase also can accompany organic or nutrient enrichment (Wisseman 1990), and, given the other changes in the benthic community, this may be the case for East Spring Creek at Granite View.

Dominant taxa in the reach of Trumbull Creek near its mouth included the elmud *Cleptelmis* sp., the relatively tolerant mayfly *Ephemerella* sp., blackflies and tolerant midges. Improvement in the total bioassessment score since 1994 has resulted mainly from small changes in several metrics, all of which can be traced to the addition of more tolerant taxa, including the worm *Nais* sp. and fingernail clam *Pisidium* sp. A small increase in the biotic index (mean value 4.79 in 1994 and 5.00 in 1996) would be even greater (to 5.17 in 1996) if the more appropriate value for *Ephemerella* (probably *E. inermis*) had been used in the 1996 calculation. It appears that the total bioassessment score is misleading in the case of the Trumbull Creek site: organic and/or nutrient pollution is indicated by the composition of the benthic community at this site.

Bioassessment scores for East Spring Creek below Farrier's dam have remained consistently low in all years of study, and, since 1992, the trend here has been a decline in benthic community health, though habitat scores have tended to improve over the same time span. High abundances of the aquatic isopod *Caecidotea* sp. noted in all years of study has kept the biotic index score high: in 1996, this organism comprised 43% of the sampled assemblage, and the biotic index stood at 6.43, indicating a pollution-tolerant community. Large numbers of filter-feeders (31% of the sample in 1996) are characteristic of an outflow system, such as that below a dam. Both EPT abundance and EPT richness have declined dramatically at this site over the years of study, further evidence of declining water quality.

Figure 4. Bioassessment vs. habitat scores, East Spring and Trumbull Creeks, 1989-1996.

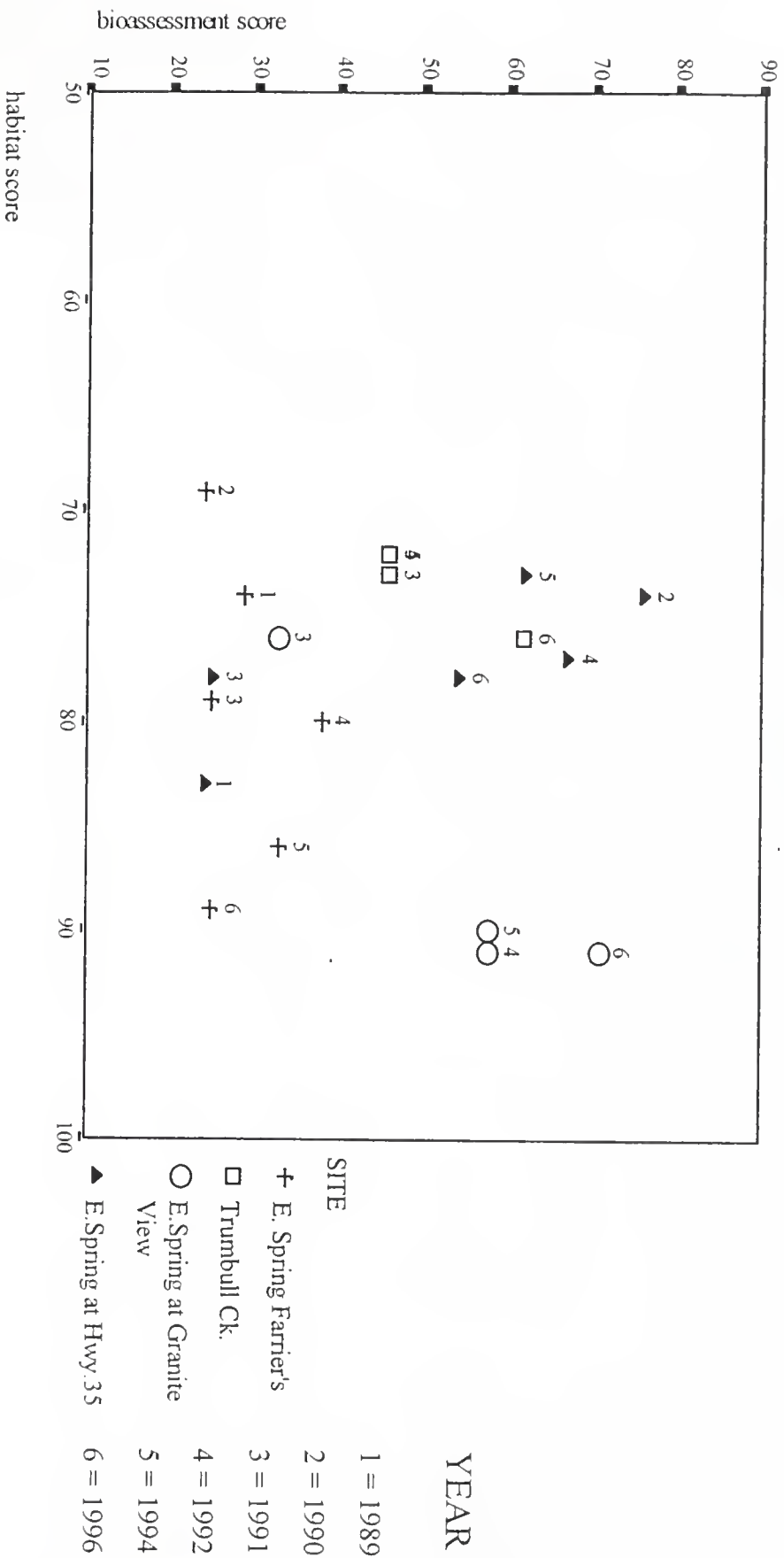


Figure 4 illustrates the relationship between the total habitat scores and total bioassessment scores of the four sites over the six years of study. The relationships must be interpreted with caution, however, because of the problems associated with bioassessment scores described above.

## CONCLUSIONS

- Bioassessment scores for East Spring and Trumbull Creeks generally do not seem to be accurate descriptors of biotic health at some sites. While scores have shown improvement in 1996 at Granite View and Trumbull Creek, communities at these sites are increasingly dominated by pollution tolerant taxa. It appears that increasing organic and/or nutrient pollution at these sites is reflected in the taxonomic composition of the benthic community, but has been “camouflaged” in total bioassessment scores.
- Increasingly poor water quality probably due to organic and/or nutrient pollution is indicated at all four sites by increasing biotic index scores, which have risen from 8% to 14% since 1994.
- Habitat conditions do not appear to be a limiting factor in the biological health of East Spring and Trumbull Creeks. All sites were classified as sub-optimal or optimal in every assessment since 1989. In fact, perceived habitat quality continues to improve below Farrier’s dam, and at least slight improvement was perceived at all other sites in 1996.
- Non-point source pollution continues to degrade East Spring Creek and Trumbull Creek near its mouth. Data from the 1996 survey probably show this degradation to be worsening.

## TABLES

**Table 1. Internal reference values and criteria for assigning scores to metrics based on percent comparability to reference values (adapted from McGuire 1995):**

metric	East Spring and Trumbull Creeks reference 1996	Scoring Criteria				*
		3	2	1	0	
Taxa richness	31	> 80%	80-60%	60-40%	< 40%	a
EPT richness	8	> 85%	85-70%	70-50%	< 50%	a
Biotic index	3.80	> 90%	90-80%	80-70%	< 70%	b
% dominant taxon	15	> 60%	60-45%	45-30%	< 30%	b
%Collector(g+lf)	71	> 90%	90-80%	80-70%	< 70%	b
% Scraper +Shredder	22	> 80%	80-60%	60-40%	< 40%	a
% EPT	70	> 75%	75-50%	50-25%	< 25%	a
% Hydropsych. of Trichop.	0	< 50%	50-70%	70-90%	> 90%	c
Shannon diversity (log2)	4.15	>90%	90-80%	80-70%	<70%	a
<sup>1</sup> 1996 Internal reference values are the "best" appropriate values among those calculated in six years of East Spring and Trumbull Creeks data.  * a = score is ratio of study site to reference x 100.  * b = score is ratio of reference to study site x 100.  * c = score is based on the actual value, not a percentage of reference.						

Table 2a. Criteria for the assignment of support classifications / standards violation thresholds (from Bukantis, 1997)	
% Comparability to reference	Use support
>75	Full support--standards not violated
25-75	Partial support--moderate impairment--standards violated
<25	Non-support--severe impairment--standards violated
Table 2b. Criteria for the assignment of impairment classifications (from Plafkin et al. 1989).	
% Comparability to reference	Classification
> 83	nonimpaired
54-79	slightly impaired
21-50	moderately impaired
<17	severely impaired

**Table 3. Mean metric values, percentage of reference, and bioassessments for East Spring and Trumbull Creeks, September 5, 1996.**

metric	East Spring Creek at Hwy. 35	East Spring Creek at Granite View <sup>1</sup>	Trumbull Creek near mouth	East Spring Creek below Farrer's dam <sup>1</sup>
Taxa richness	26.5	31	25.5	28
EPT richness	6	7	5.5	3
Biotic index	5.18	5.66	5.00	6.43
% dominant taxon	26	18	19	43
% Collector (g+ff)	90	77	82	93
% Scrapers + Shredders	2.5	12	10.5	2
% EPT	20	21	19	11
% Hydropsychinae of Trichoptera	3.5	0	0	100
Shannon diversity(log2)	3.55	4.15	4.04	3.05
% of reference				
Taxa richness	85	100	82	90
EPT richness	75	88	69	38
Biotic index	73	67	76	59
% dominant taxon	58	83	79	35
% Collector (g+ff)	79	92	87	76
% Scrapers + Shredders	11	55	48	9
% EPT	29	30	27	100
% Hydropsychinae of Trichoptera	3.5	0	0	16
Shannon diversity(log2)	86	100	97	73
metric score				
Taxa richness	3	3	3	3
EPT richness	2	3	1	0
Biotic index	1	0	1	0
% dominant taxon	2	3	3	1
% Collector (g+ff)	1	3	2	1
% Scrapers + Shredders	0	1	1	0
% EPT	1	3	1	0
% Hydropsychinae of Trichoptera	3	1	3	0
Shannon diversity(log2)	2	3	3	1
total score (max = 27)	15	20	18	6
% reference	56	74	67	22
classification *	SLI	SLI	SLI	MOD
use support	PARTIAL	PARTIAL	PARTIAL	PARTIAL

\* classifications: (NON) non-impaired, (SLI) slightly impaired, (MOD) moderately impaired, (SEV) severely impaired<sup>1</sup> Data based on single samples.

Table 4. Stream and riparian habitat assessment: East Spring and Trumbull Creeks, September 5, 1996.

Max. possible score	Location:	East Spring Creek at Hwy.35	East Spring Creek at Granite View	Trumbull Creek near mouth	East Spring Creek below Farrier's dam	Mean habitat values
10	Parameter	10	7	10	2	7
10	riffle development	8	10	8	8	8.5
20	substrate development	13	20	16	20	17
20	embeddiness	14	18	20	20	18
20	channel alteration	20	18	18	20	17.5
20	sediment deposition	9/9	8/8	10/10	10/10	20
10/10	flow status	10/10	10/10	8/8	10/10	9/9
10/10	bank stability (right/left)	4/4	10/8	2/2	10/10	9.5/9.5
10/10	bank vegetative cover					6.5/6
10/10	riparian width (right/left)					
160	TOTAL:	125	147	132	150	137.5
	PERCENT OF MAXIMUM:	78	92	82.5	94	86
	CONDITION <sup>1</sup> :	SUB-OPTIMAL	OPTIMAL	OPTIMAL	OPTIMAL	OPTIMAL

1. Condition categories: Optimal > 81% of maximum score; Sub-optimal 75 - 56%; Marginal 49 - 29%; Poor <23%.

Table 5. Trends in habitat condition. East Spring and Trumbull Creeks, 1989-1996.

East Spring Creek at Hwy. 35					E Spring Cr. at Granite View <sup>1</sup>					Trumbull Creek at mouth					East Spring Creek below Farrer's dam						
YEAR	89	90	91	92	94	96	91	92	94	96	89	91	92	94	96	89	90	91	92	94	96
substrate *	18	18	20	20	17	16	20	20	19	20	16	20	18	16	16	18	20	20	20	19	16
embeddedness *	13	19	20	20	13	13	18	20	20	20	17	17	17	14	16	18	19	20	20	20	20
discharge/vel. depth	18	14	15	18	16		10	18	18		14	17	17	12		11	12	11	12	10	
channel alteration *	19	13	16	13	11	14	16	19	20	18	19	16	19	20	20	17	8	20	20	20	20
substrate stability	19	12	19	17	15		20	19	19		17	17	19	11		17	8	19	20	20	
pool/riffle ratio	13	13	11	16	8		12	16	11		12	15	15	11		7	7	11	12	9	
flow status					20	20			20	20				16	20					20	20
bank stability *	18	14	20	16	20	18	20	20	20	16	8	16	14	20	20	18	20	18	20	20	20
bank vegetation *	18	18	20	18	18	20	20	20	20	20	14	20	18	20	16	18	20	20	20	20	20
riparian width			2	4	4	8	10	10	10	18		2	2	2	4			10	8	12	20
sediment deposition						14				18					18					20	
riffle development						17				14					17						4
canopy cover			18	14			12	18				10	10					15	15		
streamside cover	14	12	10	14	18		20	20	20		12	10	10	16		10	10	10	10	20	
* Total: 5 parameters common to all assessments (100 max score)	86	82	96	87	79	81	94	99	99	94	74	89	86	90	88	89	87	98	100	99	96
classification <sup>1</sup>	opt	opt	opt	opt	sub	opt	opt	opt	opt	opt	sub	opt	opt	opt	opt	sub	opt	opt	opt	opt	opt
Total: All scored parameters	150	133	171	170	160	140	168	200	197	164	129	160	159	158	137	134	124	174	177	190	160
Max. possible score	180	180	220	220	220	180	220	220	220	180	180	220	220	220	180	180	180	220	220	220	180
percent of max score	83	74	78	77	73	78	76	91	90	91	72	73	72	72	76	74	69	79	80	86	89
classification <sup>1</sup>	opt	sub	sub	sub	sub	sub	sub	opt	opt	opt	sub	sub	sub	sub	sub	sub	sub	sub	opt	opt	opt

<sup>1</sup>For criteria see note for Table 4.

Table 6. Trends in bioassessment metric scores. East Spring and Trumbull Creeks, 1989-1996.

	East Spring Creek at Hwy. 35					E. Spring Cr. at Granite View					Trumbull Creek near mouth					East Spring Creek below Farrier's dam				
YEAR	89 <sup>1</sup>	90 <sup>1</sup>	91	92	94	96	91	92	94	96	91	92	94	96	89 <sup>1</sup>	90 <sup>1</sup>	91	92	94	96
# of taxa	12	15	15.5	19	28	24	17	22	24	31	21	22.5	24.5	25.5	11	11	14	22	21	25
EPT richness	3	5	3	3	8	6	4	8	5	7	5	5	5	5.5	2	4	4	6	5	3
Biotic index	5.61	4.04	5.17	4.00	4.54	5.18	4.67	3.80	4.99	5.66	4.50	4.74	4.79	5.00	6.67	5.17	5.69	5.06	5.88	6.43
% dominant	51	45	56	30	25	26	40	33	23	18	27.5	25.5	25.5	19	32	64	59	59	38	43
% collectors	94	78	94	71	83	90	96	94	83	77	94	95.5	85	82	87	94	99	92	95	93
% scrape +shred	6	21	3.5	22	14	2.5	2	2	12	12	5	3.5	6	10.5	13	1	1	3	3	2
Hydro./ Trich.	0	2	25	0	3	3.5	84	72	9	0	58.5	14.5	0	0	100	99	100	97	100	100
% EPT	19	63	4	8	12	20	9	28	24	21	3.5	12	14.5	19	20	69	64	70	46.5	11
Shannon diversity	2.30	2.65	2.32	3.15	3.60	3.55	2.56	3.27	3.66	4.15	3.22	3.43	3.51	4.04	2.51	1.97	2.07	2.45	3.06	3.05
Percent of reference based on 1996 ref.	24	76	25	67	62	62	33	58	58	71	46	46	46	62	29	24	25	38	33	25
Classification based on 1996 internal reference	mod	slt	mod	slt	slt	slt	mod	slt	slt	slt	mod	mod	mod	slt	mod	mod	mod	mod	mod	mod
Use support category based on 1996 reference	non	full	non	part	part	part	part	part	part	part	part	part	part	part	part	non	non	part	part	non

<sup>1</sup>Based on 100-organism sub-samples. Classifications and use support categories determined using all metrics except number of taxa and EPT richness. All other years' data is based on approx. 300-organisms subsamples, and classifications and use support categories determined using all metrics except Shannon diversity.

**Table 7. Trends in dominant taxa. East Spring and Trumbull Creeks. 1989-1996.**

<b>E.Spring at Hwy.35</b>	<b>E.Spring Granite View</b>	<b>Trumbull Creek</b>	<b>E.Spring Farrier's</b>
<b>1989</b>			<b>1989</b>
<i>Simulium</i> 51%			<i>Caecidotea</i> 32%
<i>Baetis tricaudatus</i> 17%			<i>Simulium</i> 29%
Chironomidae 13%			<i>Cheumatopsyche</i> 19%
<i>Optioservus</i> 5%			<i>Gyraulus</i> 5%
Lumbricidae 3%			Chironomidae 4%
<b>1990</b>			<b>1990</b>
<i>Oxyethira</i> 45%			<i>Cheumatopsyche</i> 64%
<i>Brychius</i> 16%			Chironomidae 10%
<i>Baetis tricaudatus</i> 12%			Lumbricidae 6%
Chironomidae 6%			<i>Caecidotea</i> 6%
<i>Zaitzevia</i> 5%			<i>Ophiogomphus</i> 5%
<b>1991</b>	<b>1991</b>	<b>1991</b>	<b>1991</b>
<i>Simulium</i> 56%	<i>Simulium</i> 40%	<i>Parametriocnemus</i> 23%	<i>Cheumatopsyche</i> 59%
<i>Pagastia</i> 13%	<i>Pagastia</i> 27%	<i>Zaitzevia</i> 15%	<i>Caecidotea</i> 15%
<i>Optioservus</i> 6%	<i>Orthocladius</i> 12%	<i>Pagastia</i> 14%	<i>Simulium</i> 10%
<i>Eukiefferiella</i> 4%	<i>Cheumatopsyche</i> 5%	<i>Tvetenia</i> 9%	<i>Hyaella azteca</i> 4%
<i>Zaitzevia</i> 4%	<i>Optioservus</i> 4%	<i>Optioservus</i> 8%	<i>Optioservus</i> 3%
<b>1992</b>	<b>1992</b>	<b>1992</b>	<b>1992</b>
<i>Pagastia</i> 30%	<i>Pagastia</i> 33%	<i>Zaitzevia</i> 25%	<i>Cheumatopsyche</i> 59%
<i>Optioservus</i> 17%	<i>Baetis tricaudatus</i> 17%	<i>Orthocladius</i> 14%	<i>Polypedium</i> 10%
<i>Brychius</i> 16%	<i>Optioservus</i> 12%	<i>Parametriocnemus</i> 12%	<i>Simulium</i> 7%
<i>Micropsectra</i> 7.5%	<i>Orthocladius</i> 5%	<i>Optioservus</i> 11%	<i>Baetis tricaudatus</i> 5%
<i>Simulium</i> 6%	<i>Simulium</i> 4%	<i>Baetis tricaudatus</i> 8%	<i>Optioservus</i> 2%
<b>1994</b>	<b>1994</b>	<b>1994</b>	<b>1994</b>
<i>Micropsectra</i> 18%	<i>Simulium</i> 23%	<i>Cleptelmis</i> 25%	<i>Cheumatopsyche</i> 38%
<i>Pagastia</i> 15%	<i>Optioservus</i> 14%	<i>Optioservus</i> 16%	<i>Caecidotea</i> 15%
<i>Simulium</i> 12%	<i>Baetis tricaudatus</i> 14%	<i>Simulium</i> 12%	<i>Hyaella azteca</i> 9%
<i>Cricotopus</i> 9%	<i>Dipheter hageni</i> 7%	<i>Turbellaria</i> 9%	<i>Simulium</i> 8%
<i>Brychius</i> 8%	Lymnaeidae 6%	<i>Baetis tricaudatus</i> 8%	<i>Rheotanytarsus</i> 5%
<b>1996</b>	<b>1996</b>	<b>1996</b>	<b>1996</b>
<i>Simulium</i> 26%	<i>Nais</i> 18%	<i>Cleptelmis</i> 19%	<i>Caecidotea</i> 43%
<i>Eukiefferiella</i> 14%	<i>Eukiefferiella</i> 13%	<i>Ephemerella</i> 9%	<i>Simulium</i> 16%
<i>Micropsectra</i> 9%	<i>Orthocladius</i> 9%	<i>Simulium</i> 9%	<i>Theinmanninia</i> 5%
<i>Baetis</i> 9%	<i>Simulium</i> 8%	<i>Rheocricotopus</i> 8%	<i>Rheotanytarsus</i> 4%
<i>Cleptelmis</i> 8%	<i>Optioservus</i> 6%	<i>Orthocladius</i> 8%	<i>Baetis tricaudatus</i> 3%

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## APPENDIX A

# Macroinvertebrate Taxonomic Data

## EAST SPRING CREEK at Highway 35 Crossing

Taxon	1.1		1.2		BI <sup>2</sup>	FFG <sup>1</sup>
	#	%	#	%		
Turbellaria	5	1.69	0	0	4	PR
Lumbricidae	8	2.71	4	1.38	4	CG
Nais	7	2.37	21	7.27	8	CG
Ophiodonais	1	.34	0	0	6	CG
Lymnaeidae	2	.68	0	0	6	SC
Acari	7	2.37	6	2.08	5	PA
TOTAL: MISC. TAXA	30	10.17	31	10.73		
Baetis	17	5.76	34	11.76	5	CG
Baetis tricaudatus	8	2.71	20	6.92	4	CG
Ephemerella	9	3.05	4	1.38	2	SC
TOTAL: EPHEMEROPTERA	34	11.53	58	20.07		
Glossosoma	1	.34	0	0	0	SC
Hydropsychidae	1	.34	0	0	4	CF
Hydroptilidae	3	1.02	5	1.73	4	PH
Hydroptila	10	3.39	3	1.04	6	CG
TOTAL: TRICHOPTERA	15	5.08	8	2.77		
Cleptelmis	46	15.59	2	.69	4	CG
Optioservus	4	1.36	1	.35	5	CG
Brychius	1	.34	0	0	5	SH
TOTAL: COLEOPTERA	51	17.29	3	1.04		
Chelifera	0	0	1	.35	6	PR
Pericoma	1	.34	0	0	4	CG
Simulium	86	29.15	66	22.84	5	CF
TOTAL: DIPTERA	87	29.49	67	23.18		
Chironomidae-pupae	3	1.02	11	3.81	6	UN
Cricotopus bicinctus Gr.	2	.68	1	.35	7	CG
Cricotopus trifascia Gr.	3	1.02	0	0	6	CG
Dicortendipes	0	0	1	.35	8	CG
Eukiefferiella	48	16.27	33	11.42	8	CG
Micropsectra	9	3.05	44	15.22	4	CG
Nanocladius	0	0	1	.35	3	CG
Orthocladiinae	1	.34	2	.69	6	CG
Orthocladius	4	1.36	1	.35	6	CG
Pagastia	6	2.03	13	4.50	1	CG
Parametriocnemus	0	0	2	.69	5	CG
Rheocricotopus	0	0	7	2.42	4	CG
Rheotanytarsus	1	.34	5	1.73	6	CF
Theinmanniella	1	.34	1	.35	6	CG
TOTAL: CHIRONOMIDAE	78	26.44	122	42.21		
GRAND TOTAL	295	100.00	289	100.00		

1. Functional feeding group designations are given in TABLE A.

2. Biotic index scores for individual taxa, as given in Burkhardt, 1996.

# **Aquatic Macroinvertebrate Data: East Spring Creek at Highway 35 Crossing**

Sample:	1.1	1.2
% of sample used:	unknown	unknown
Subsample size	295	289
Taxa richness	28	25
EPT richness	7	5
Biotic index	5.20	5.15
% Dominant taxon	29	23
% EPT	17	23
% Collectors (g+f)	89	91
% Scrapers + Shredders	4.41	1
% Hydropsychinae of Trich	7	0
Metals tolerance index	5.20	4.64
Shannon Diversity (log2)	3.52	3.58
EPT/Chironomidae	.63	.54
CTQa	95.50	101.88
%Baetidae of Ephemeroptera	74	93
% Coleoptera	17	1
% Diptera	29	23
% Chironomidae	26	42
% Ephemeroptera	12	20
% Plecoptera	0	0
% Trichoptera	5	3
% multivoltine	34	50
% univoltine	49	49
% semivoltine	17	1

Functional Feeding Grp.	%RA	# taxa	%RA	# taxa
Filterers	30	3	25	2
Collector-Gatherers	60	17	66	18
Shredders	<1	1	0	0
Scrapers	4	3	1	1
Predators	2	1	<1	1

Est. total number of organisms	unknown	unknown
Est. number collected per foot	unknown	unknown
Est. number collected per minute	unknown	unknown

# Macroinvertebrate Taxonomic Data

EAST SPRING CREEK:  
at Granite View

2.0

Taxon	#	%	BI	FFG
Turbellaria	17	5.54	4	PR
Lumbricidae	1	.33	4	CG
Nais	55	17.92	8	CG
Pisidium	1	.33	8	CG
Lymnacidac	14	4.56	6	SC
Valvatidae	2	.65	3	SC
Caecidotca	2	.65	8	CG
Acari	9	2.93	5	PA
TOTAL: MISC. TAXA	101	32.90		
Baetis	9	2.93	5	CG
Bactis tricaudatus	18	5.86	4	CG
Ephemerella	8	2.61	2	SC
TOTAL: EPHEMEROPTERA	35	11.40		
IHydroptilidae	3	.98	4	PH
Hydroptila	1	.33	6	CG
Oxyethira	1	.33	3	PH
Lepidostoma	7	2.28	1	SH
TOTAL: TRICHOPTERA	12	3.91		
Cleptelmis	6	1.95	4	CG
Optioservus	18	5.86	5	CG
Brychius	4	1.30	5	SH
Haliplus	1	.33	5	SH
TOTAL: COLEOPTERA	29	9.45		
Linnophora	1	.33	6	PR
Pericoma	1	.33	4	CG
Simulium	25	8.14	5	CF
TOTAL: DIPTERA	27	8.79		
Chironomidae-pupae	4	1.30	6	UN
Cricotopus Bicinctus Gr.	1	.33	7	CG
Eukiefferiella	39	12.70	8	CG
Micropsectra	3	.98	4	CG
Orthocladiinae	4	1.30	6	CG
Orthocladius	29	9.45	6	CG
Pagastia	7	2.28	1	CG
Parametrioenemus	4	1.30	5	CG
Rheocricotopus	8	2.61	4	CG
Rheotanytarsus	3	.98	6	CF
Synorthocladius	1	.33	2	CG
TOTAL: CHIRONOMIDAE	103	33.55		
GRAND TOTAL	307	100.00		

# **Aquatic Macroinvertebrate Data: East Spring Creek at Granite View**

Sample:	2.0	
% of sample used:	unknown	
Subsample size	307	
Taxa richness	33	
EPT richness	7	
Biotic index	5.66	
% Dominant taxon	18	
% EPT	21	
% Collectors (g+f)	77	
% Scrapers + Shredders	12	
% Hydropsychinae of Trich	0	
Metals tolerance index	5.10	
Shannon Diversity (log2)	4.15	
EPT/Chironomidae	.46	
CTQa	95.58	
%Baetidae of Ephemeroptera	77	
% Coleoptera	9	
% Diptera	9	
% Chironomidae	34	
% Ephemeroptera	11	
% Plecoptera	0	
% Trichoptera	4	
% multivoltine	41	
% univoltine	49	
% semivoltine	10	
Functional Feeding Grp.	%RA	# taxa
Filterers	9	2
Collector-Gatherers	68	19
Shredders	4	3
Scrapers	8	3
Predators	6	2
Est. total number of organisms	unknown	
Est. number collected per foot	unknown	
Est. number collected per minute	unknown	

# Macroinvertebrate Taxonomic Data

TRUMBULL CREEK at mouth

Taxou	3.1		3.2		BI	FFG
	#	%	#	%		
Turbellaria	3	.96	3	1.09	4	PR
Nematomorpha	1	.32	0	0	11	PA
Enchytraeidae	7	2.24	1	.36	4	CG
Nais	14	4.47	20	7.30	8	CG
Tubificidae	4	1.28	4	1.46	10	CG
Pisidium	12	3.83	0	0	8	CG
Lymnaeidae	3	.96	0	0	6	SC
Physidae	2	.64	0	0	8	SC
Caccidotea	4	1.28	2	.73	8	CG
Acari	2	.64	6	2.19	5	PA
TOTAL: MISC. TAXA	52	16.61	36	13.14		
Bactis	13	4.15	25	9.12	5	CG
Bactis tricaudatus	3	.96	2	.73	4	CG
Ephemerella	32	10.22	21	7.66	2	SC
TOTAL: EPHEMEROPTERA	48	15.34	48	17.52		
Hydroptilidae	5	1.60	6	2.19	4	PH
Hydroptila	5	1.60	4	1.46	6	CG
Lepidostoma	4	1.28	0	0	1	SH
TOTAL: TRICHOPTERA	14	4.47	10	3.65		
Cleptelmis	71	22.68	42	15.33	4	CG
Optioservus	1	.32	4	1.46	5	CG
Brychius	1	.32	1	.36	5	SH
TOTAL: COLEOPTERA	73	23.32	47	17.15		
Diptera	0	0	1	.36	11	UN
Simulium	18	5.75	33	12.04	5	CF
TOTAL: DIPTERA	18	5.75	34	12.41		
Chironomidae-pupae	4	1.28	11	4.01	6	UN
Corynoneura	2	.64	0	0	6	CG
Cricotopus Bicinctus Gr.	1	.32	0	0	7	CG
Eukiefferiella	17	5.43	16	5.84	8	CG
Micropsectra	3	.96	0	0	4	CG
Orthocladiinae	2	.64	3	1.09	6	CG
Orthocladius	30	9.58	16	5.84	6	CG
Pagastia	4	1.28	5	1.82	1	CG
Parametriocnemus	13	4.15	10	3.65	5	CG
Rheocricotopus	23	7.35	24	8.76	5	CG
Rheotanytarsus	9	2.88	10	3.65	6	CF
Synorthocladius	0	0	3	1.09	2	CG
TOTAL: CHIRONOMIDAE	108	34.50	99	36.13		
GRAND TOTAL	313	100.00	274	100.00		

# **Aquatic Macroinvertebrate Data: Trumbull Creek at mouth**

Sample:	3.1	3.2
% of sample used:	unknown	unknown
Subsample size	313	274
Taxa richness	31	26
EPT richness	6	5
Biotic index	4.96	5.03
% Dominant taxon	23	15
% EPT	19	19
% Collectors (g+f)	82	82
% Scrapers + Shredders	13	8
% Hydropsychinae of Trich	0	0
Metals tolerance index	4.31	4.61
Shannon Diversity (log2)	4.06	4.03
EPT/Chironomidae	.57	.59
CTQa	98.53	100.24
%Baetidae of Ephemeroptera	33	56
% Coleoptera	23	17
% Diptera	6	12
% Chironomidae	35	36
% Ephemeroptera	15	18
% Plecoptera	0	0
% Trichoptera	4	4
% multivoltine	34	40
% univoltine	41	42
% semivoltine	25	17

Functional Feeding Grp.	%RA	# taxa	%RA	# taxa
Filterers	9	2	16	2
Collector-Gatherers	73	19	66	17
Shredders	2	2	<1	1
Scrapers	12	3	8	1
Predators	1	1	1	1

Est. total number of organisms	unknown	unknown
Est. number collected per foot	unknown	unknown
Est. number collected per minute	unknown	unknown

# Macroinvertebrate Taxonomic Data

EAST SPRING CREEK:

below Farrier's dam

4.0

Taxon	#	%	BI	FFG
Turbellaria	2	.69	4	PR
Enchytraeidae	2	.69	4	CG
Nais	2	.69	8	CG
Tubificidae	2	.69	10	CG
Hyalolella azteca	1	.34	8	CG
Caecidotea	124	42.61	8	CG
Pacifastacus	1	.34	6	OM
Aeari	5	1.72	5	PA
TOTAL: MISC. TAXA	139	47.77		
Baetis	1	.34	5	CG
Baetis tricaudatus	10	3.44	4	CG
TOTAL: EPHEMEROPTERA	11	3.78		
Chumatopsyche	31	10.65	5	CF
TOTAL: TRICHOPTERA	31	10.65		
Petrophila	5	1.72	5	SC
TOTAL: LEPIDOPTERA	5	1.72		
Optioservus	1	.34	5	CG
Zaitzevia	1	.34	4	SC
TOTAL: COLEOPTERA	2	.69		
Empididae	1	.34	6	PR
Hemerodromia	1	.34	6	PR
Simulium	47	16.15	5	CF
TOTAL: DIPTERA	49	16.84		
Chironomidae-pupae	5	1.72	6	UN
Damesa	4	1.37	5	CG
Eukiefferiella	2	.69	8	CG
Micropsectra	1	.34	4	CG
Orthocladinae	1	.34	6	CG
Orthocladus	1	.34	6	CG
Pagastia	3	1.03	1	CG
Polypedilum	6	2.06	6	CG
Rheotanytarsus	13	4.47	6	CF
Thienemannella	3	1.03	6	CG
Thienemannimyia	15	5.15	6	CG
TOTAL: CHIRONOMIDAE	54	18.56		
GRAND TOTAL	291	100.00		

**Aquatic Macroinvertebrate Data:** East Spring Creek below Farrier's dam

Sample:	4.0	
% of sample used:	unknown	
Subsample size	291	
Taxa richness	28	
EPT richness	3	
Biotic index	6.43	
% Dominant taxon	43	
% EPT	11	
% Collectors (g+f)	93	
% Scrapers + Shredders	2	
% Hydropsychinae of Trich	100	
Metals tolerance index	4.70	
Shannon Diversity (log2)	3.05	
EPT/Chironomidae	.78	
CTQa	102.93	
%Baetidae of Ephemeroptera	100	
% Coleoptera	1	
% Diptera	17	
% Chironomidae	19	
% Ephemeroptera	4	
% Plecoptera	0	
% Trichoptera	11	
% multivoltine	22	
% univoltine	77	
% semivoltine	1	
Functional Feeding Grp.	%RA	# taxa
Filterers	31	3
Collector-Gatherers	61	17
Shredders	0	0
Scrapers	2	2
Predators	1	3
Est. total number of organisms	unknown	
Est. number collected per foot	unknown	
Est. number collected per minute	unknown	

TABLE A. Functional Feeding Groups

Abbreviation	Description
CF	Collector - filterer
CG	Collector - gatherer
OM	Omnivore
PA	Parasite
PR	Predator
SC	Scraper
UN	Unknown
SH	Shredder



